

**Context Free Grammars**

1. List the 4 components of a context free grammar.
2. Describe the relationship between terminals, non-terminals, and productions.
3. Define ambiguity.
4. Describe the difference between scanning & parsing.
5. Describe the language accepted by the following grammar:
  - a.  $S \rightarrow abS \mid a$
  - b.  $S \rightarrow aSb \mid \varepsilon$
  - c.  $S \rightarrow bSb \mid A$   
 $A \rightarrow aA \mid \varepsilon$
  - d.  $S \rightarrow AS \mid B$   
 $A \rightarrow aAc \mid Aa \mid \varepsilon$   
 $B \rightarrow bBb \mid \varepsilon$
  - e.  $S \rightarrow S \text{ and } S \mid S \text{ or } S \mid (S) \mid \text{true} \mid \text{false}$
6. Which of the previous grammars are left recursive?
7. Which of the previous grammars are ambiguous? Provide proof.
8. Creating Grammars
  - a. Write a grammar for  $a^x b^y$ , where  $x = y$
  - b. Write a grammar for  $a^x b^y$ , where  $x > y$
  - c. Write a grammar for  $a^x b^y$ , where  $x = 2y$
  - d. Write a grammar for  $a^x b^y a^z$ , where  $z = x + y$
  - e. Write a grammar for  $a^x b^y a^z$ , where  $z = x - y$
9. Derivations, Parse Trees, Precedence and Associativity For the following grammar:  $S \rightarrow S \text{ and } S \mid \text{true}$ 
  - a. List 4 derivations for the string “true and true and true”.
  - b. Label each derivation as left-most, right-most, or neither.
  - c. List the parse tree for each derivation
  - d. What is implied about the associativity of “and” for each parse tree?
10. For the following grammar:  $S \rightarrow S \text{ and } S \mid S \text{ or } S \mid \text{true}$ 
  - i. List all parse trees for the string “true and true or true”
  - ii. What is implied about the precedence/associativity of “and” and “or” for each parse tree?
  - iii. Rewrite the grammar so that “and” has higher precedence than “or” and is right associative

Best wishes

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